# DOCUMENT RESUME

ED 034 898 VT 010 109

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|---|---|
| AUTHOR | Householder, Daniel L.; Suess, Alan R. |
| TITLE | Review and Synthesis of Research in Industrial Arts Education. Research Series No. 42. |
| INSTITUTION | Ohio State Univ., Columbus. Center for Vocational and Technical Education. |
| SPONS AGENCY | Office of Education (DHEW), Washington, D.C. Bureau of Research. |
| PUB DATE | Oct 69 |
| NOTE | 69p. |
| AVAILABLE FROM | The Center for Vocational and Technical Education, The Ohio State University, 1900 Kenny Road, Columbus, Ohio 43210 ($2.25) |
| EDRS PRICE | EDRS Price MF-$0.50 HC-$3.55 |
| DESCRIPTORS | Bibliographies, Doctoral Theses, *Industrial Arts, Literature Reviews, Periodicals, Research, *Research Reviews (Publications), *Synthesis |

ABSTRACT

This document provides an analysis and synthesis of the research in industrial arts education during the period 1966 through 1968, inclusive. Journal articles and doctoral dissertations were the primary sources for studies, while staff studies and reports of funded research were used when available to the reviewers. Major topics are: (1) History, Philosophy, and Objectives, (2) Curriculum Development, (3) Instructional Media and Methods, (4) Student Personnel Services, (5) Facilities and Equipment, (6) Teacher Education, (7) Administration and Supervision, (8) Research, and (9) Summary. An extensive bibliography of the reviewed literature is included. This report complements a 1968 conference on research in industrial arts, a report of which is available as ED 029 986. (GR)

ED034898

Research Series No. 42

# review and synthesis of research in Industrial Arts Education

second edition

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THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY, 1900 Kenny Rd., Columbus, Ohio 43210

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Research Series No. 42

ED034898

# REVIEW AND SYNTHESIS OF RESEARCH IN INDUSTRIAL ARTS EDUCATION

## Second Edition

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October 1969

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U.S. DEPARTMENT OF HEALTH
EDUCATION AND WELFARE

Office of Education
Bureau of Research

*This publication was prepared pursuant to a grant with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official Office of Education position or policy.*

# PREFACE

This *Review and Synthesis of Research in Industrial Arts Education* is one of a second generation of papers which assess the "state-of-the-art" in fields related to vocational and technical education. It should assist in identifying substansive problems and methodological approaches for researchers, as well as providing practitioners with a summary of research findings which have application to educational programs in this area.

In the field of industrial arts, the pace of research and development activities has increased considerably during the period under review. Gaps which exist for some readers are probably the result of the authors' prerogative to be selective of the best and most representative reports.

As one of a series of information analysis papers released by the ERIC Clearinghouse on Vocational and Technical Education, this review and synthesis is intended to provide researchers and practitioners with an authoritative analysis of the literature extant in the field. Those who wish to examine primary sources of information should utilize the bibliography. Where ED numbers and EDRS prices are cited, the documents are available in microfiche and hardcopy forms.

This review and synthesis complements a conference sponsored by The Center for Vocational and Technical Education in October of 1968. The purpose of this conference was to review relevant completed research and to identify priority research areas in industrial arts. Both authors of this review were involved in the conference, Alan R. Suess preparing its final report entitled *National Conference on Research in Industrial Arts.*

The profession is indebted to Daniel L. Householder and Alan R. Suess for their scholarship in the preparation of this noteworthy contribution to the field. Recognition is also due Jerome Moss, Jr., University of Minnesota; Frank C. Pratzner, The Ohio State University; Paul W. DeVore, West Virginia University; and Wilbur R. Miller, University of Missouri for their critical review of the manuscript prior to its final revision and publication.

Members of the profession are invited to offer suggestions for the improvement of the review and synthesis series and by suggesting specific topics or problems for future reviews.

Robert E. Taylor
Director
The Center for Vocational and
Technical Education

# INTRODUCTION

This document is an attempt to provide an analysis and synthesis of the research in industrial arts education during the period 1966 through 1968, inclusive. To the degree that it has been successful in meeting this objective, it reflects the "state of the art" during the three-year period. In a few instances, earlier studies were included where they improved the perspective of the coverage in a particular section.

The search to identify studies was concentrated in two major areas: journal articles and doctoral dissertations. The journals in industrial arts education have demonstrated an increasing concern for research in recent years and have included numerous articles reporting research results. The large number of doctoral dissertations in industrial arts education made reading them all as complete reports physically impossible; in most instances, abstracts were consulted in the preparation of this document.

Staff studies and the reports of funded research have been included when these were available to the reviewers. Similarly, reports in the ERIC system dealing with industrial arts research have been reviewed and listed in the bibliography with EDRS ordering information. As a general rule, master's theses, reports of nondissertation research, and mimeographed materials have been reviewed only if they were available through the ERIC system at the time this review was prepared. While the authors recognize the excellent quality of some of the more fugitive types of reports, they were also concerned that the reader be able to consult the original sources. This can rarely be done for such documents except through the ERIC system. In order to insure long-term availability of reports, researchers are strongly encouraged to send copies to the ERIC-VT Clearinghouse.

Research in industrial arts is analyzed within a relatively broad perspective in this paper. Theoretical and speculative literature was included in those instances when the reviewers considered a more inclusive review of the literature to be important to the understanding of the industrial arts research reported. Similarly, some studies which investigated various vocational or technical education areas were considered if the research had obvious implications for industrial arts.

The authors wish to express their gratitude to Jerry Streichler, whose pioneering efforts resulted in the first edition of this volume. We also wish to thank Robert E. Taylor, director, and the staff of The Center for Vocational and Technical Education, for providing us with the opportunity to prepare this paper.

Daniel L. Householder
Alan R. Suess

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# REVIEW AND SYNTHESIS OF RESEARCH IN INDUSTRIAL ARTS EDUCATION

1/2

# HISTORY, PHILOSOPHY, AND OBJECTIVES

Examinations of the historical foundations of industrial arts, investigations of the philosophical bases of the industrial arts curriculum, and research on the attainment of industrial arts objectives are included in this section. Investigations in these areas have a degree of commonality, since they deal with value-laden questions of professional importance. These studies seek to ascertain the most desirable state for the industrial arts education enterprise, consider its antecedents, chart its future course, and provide guidance for the profession as it seeks to attain long-range goals. Consequently, they are of fundamental importance as research which is foundational to investigations in other areas of industrial arts education.

Theoretical and speculative discussions of related issues have been included in those instances where the reviewers thought such studies were appropriate and necessary for an adequate synthesis of historical and philosophical research in industrial arts. It should be recognized that research in these areas typically utilizes theoretical and speculative techniques, at least to some degree. Even the highest quality of historical and philosophical research relies upon the interpretations of the investigator.

## History of Industrial Arts

The relatively short time period covered by this review has been distinguished by the appearance of an unusually large number of publications tracing the historical development of industrial arts. This wealth of recent history has not yet been fully assimilated by the profession. The recent studies of the historical heritage of the profession will be useful in future studies of the philosophical foundations of industrial arts and attempts to define educational objectives for the field.

A definitive, book-length review of the history of industrial education was prepared by Barlow (1967). A substantial portion of the work is devoted to industrial arts, beginning with the mutual heritage (in manual training and earlier programs) of industrial arts and trade and industrial education. Considerable emphasis was placed upon the Mississippi Valley Conference in the study of professional organizations in industrial arts. Barlow reviewed the status of industrial arts teacher education in 1918, then traced its development into the 1960's, including a discussion of the several publication series and programs which evolved among industrial arts teacher education groups and organizations. A significant chapter was devoted to educational and social influences upon the development of industrial arts since 1917.

An intensive study of the decade-by-decade development of industrial arts from 1920 through the 1960's was presented by Sredl in a series of articles (1966a, 1966b, 1966d, 1967a, 1967b). This readable historical series included a thorough analysis of major trend-setting events in chronological sequence, as well as a perceptive synthesis of the educational impact of leaders, organizations, and events.

Luetkemeyer (1968) edited a major work of historical research of considerable interest and value to industrial arts teachers and teacher educators. Handicraft, machine, and automated levels of industrial production were described; the inter-related social and economic systems which have accompanied modes of production were explored in considerable depth by the chapter authors.

The psychological bases of manual training and the later behavioristic emphases in manual training, manual arts, and industrial arts were reviewed by London (1967). He traced developments in industrial arts in terms of objectives, textbooks, buildings, equipment, organization, teacher education, and the groups of learners served. The concept of the general shop was identified as the most significant organizational development in industrial arts during the period from 1916-1966. Nevertheless, London predicted that training "in depth" would become more important in industrial arts, especially in senior high school unit shops developed for highly specialized courses.

A number of historical studies in industrial arts were primarily of local interest because of the nature of the events they studied. Two studies of limited geographic scope are included here as representative of the types of problems which have been investigated. One dealt with the evolution of industrial arts programs in a state; the other followed the development of a state industrial arts association. Krempa (1966) traced the development of industrial arts in New York State from its introduction as manual training at Jamestown in 1874. The philosophical support of Dewey and Bonser at Teachers College of Columbia University was considered to be an important factor in the growth of industrial arts, as was the establishment of Oswego State Teachers College and the influence of Fales as the first state supervisor of industrial arts. Krempa noted that a substantial number of New York industrial arts educators were men whose leadership had significant national impact. Horton (1967) studied the development of the Ohio Industrial Arts Association during the period 1933-1966, noting the periods of growth and major sources of leadership within the Association.

Research which records the historical evolution of industrial arts education is vital to the establishment of a body of knowledge about the professional field. There is evidence to indicate that increased rigor is needed in historical investigations dealing with industrial arts. Problem selection and delimitation should be performed in the perspective of the overall professional need for the investigation. Improved selection and criticism of primary and secondary sources is crucial. While the complexity of causal relationships makes them difficult to establish with certitude, it is imperative that historical research concentrate upon searches for the best possible answers to the most perplexing questions in industrial arts education. Historical research is of greatest value only when it is focused upon such primary problem areas.

### Philosophical Foundations

Philosophical foundations continue to occupy an important place in the literature of industrial arts. Recent studies have been based upon both traditional and novel philosophical viewpoints. A frequent theme in recent philosophical deliberations has been the educational implications of science and technology as they affect the lives of citizens in the modern industrial culture.

Benson (1967b) investigated the structure and functions of industrial arts as reflected in the educational philosophy of Alfred North Whitehead. He suggested that industrial arts would be a part of the technical education curriculum structure as outlined by Whitehead, and would be introduced into the other curriculum structures through the technical portion. An industrial arts program compatible with Whitehead's philosophy would be taught by the problem-solving method in an attempt to stimulate creativity. It would be concerned with the "real" issues in industry and technology and provide practical experiences in research and development activities.

The characteristics of the learned professions were reviewed by Hostetler (1968), who contrasted professional education with his list of criteria. Specific suggestions for the education of industrial arts teachers were based upon the idea that teachers should be broadly educated, learned individuals. In particular, Hostetler emphasized the intellectual processes which accompany the physical activities in developing skills and techniques in industrial arts teacher education.

The impact of social and technical forces in contemporary society was explored by Kagy (1967), who recommended a set of purposes which would include the "arts" in industrial arts. His objectives included: providing opportunity for genuine creative expression to develop the individual's creative potentialities; developing an understanding of the aesthetic experience and the capacity for aesthetic response; fostering aesthetic evaluation of the environment; enriching the individual's experiences through an understanding of art forms; and increasing the individual's understanding of the arts of the past. Kagy emphasized the role of the teacher in providing experiences to build student background, which in turn would provide the basis for creative expression in industrial arts.

The development of industrial arts and vocational industrial education was traced by Svendsen (1967a, 1967b). He urged the use of the term, liberal education, to emphasize the breadth of generalizations which are a part of the conceptual structure underlying industrial arts. Svendsen proposed that industrial arts should provide industrial insight and understanding to free the individual from industrial ignorance, thereby providing the type of liberalizing base which is prerequisite to any specialized or vocational program which might be pursued later.

The importance of a general education emphasis for industrial arts may be considered as somewhat different from the stress upon the liberalizing educational values of the subject. Coger (1968) urged one major purpose for industrial arts: the interpretation of modern industry as a part of general education. The content and activities implied by this goal should be selected for their contribution to the overall educational development of the individual. Coger indicated that the need for a national sense of direction for industrial arts would also be met by the adoption of such a statement of purpose.

After studying the educational requirements of occupations, the prerequisites for free and intelligent occupational selection, and the educational requirements of a democracy, Stadt (1967) posited the point of view that the aim and content of education should be the same for all children and youth, at least through the twelfth grade. According to Stadt, this would assure that the schools were doing everything possible to maximize the opportunity for occupational choice for the students, yet make it possible for any youth to pursue his vocational or professional goals after high school completion. If the Stadt proposal were adopted, industrial arts would retain only those portions of its content which would contribute to the general education of all youth in the secondary schools.

Miller (1968) rejected the point of view that industrial arts should serve only to provide those common learnings needed by all students, or that industrial arts could be adequately defined simply by calling it a phase of general education. He proposed that industrial arts programs serve five primary functions: interpretative, exploratory, technical competency, preparatory, and supplementary. In explaining these functions, Miller indicated that industrial arts should assist youth to gain a realistic understanding of industry, and should offer students an opportunity to explore tools, materials, processes, and products. Students should have the opportunity to acquire technical competencies as a contribution to self-realization. High school industrial arts programs should serve three preparatory functions: preparatory to post-high school education; pre-vocational preparation; and general occupational readiness. In addition to these unique contributions of industrial arts, Miller recommended that the programs supplement other school subjects in the application of knowledge, the development of planning ability, sound work habits, desirable personal and social traits, and the leisure-time application of competencies acquired in the school.

A third distinct theme is apparent in the studies exploring the philosophical bases of industrial arts: the occupational contribution which industrial arts courses could and/or should provide. The need for correlation between industrial arts courses and vocational education was emphasized by Billings (1968), who encouraged the inclusion of both as a part of the total educational program for all students. Occupational orientation was advocated as an important educational goal. Pre-school experiences which would cut across traditional occupational areas were recommended as the first portion of the occupational orientation process.

Pratzner (1969) reviewed the purposes of education and the impact of social change. He developed a model of a network of spiral interactions between society, school, curriculum, and learner. Specific revisions were suggested for the nine objectives of industrial arts stated by the American Vocational Association in 1953. Pratzner recommended, for example, that the objective, interest in industry, be changed to interest in occupations, based upon the assumption that broader content coverage would result if more than industrially-affiliated occupations were studied in industrial arts. Redefinition of the objective, interest in achievement, was advocated to bring it more into alignment with the contemporary image of work. The development of leisure-time interests was considered to be an important objective for the industrial arts program. Pratzner suggested that several objectives for industrial arts be left to other programs or discarded: drawing and design, shop skills and knowledge, appreciation and use, and orderly performance. As an outgrowth of theorizing about objectives, principles, and social changes, he recommended the organization of an "Occupational Development Curriculum" for student self-concept development to replace the industrial arts programs in comprehensive high schools.

Recent philosophical studies reveal many contrasting bases for including industrial arts in the instructional programs of contemporary schools. The question of general versus occupational emphasis is neither new nor unique. The subtle differences between general and liberal programs, however, is noteworthy and indicative of the continuing evolution of philosophical thought in industrial arts.

The concept of industrial arts as liberal, liberating education provides an important area of philosophical justification for industrial arts. Content which is organized and taught in ways which will eliminate ignorance of the implications of industry in a modern world has the potential to enhance intelligent occupational choice and to assist the individual in achieving a satisfying life in an industrial world. The large number of difficult, unresolved issues should continue to stimulate philosophical scholarship in industrial arts.

## Objectives

Three studies dealing with the objectives of industrial arts and their attainment have been selected for inclusion in this review. Each of the researchers sought objective data concerning the status of industrial arts; each used a different approach and attacked a slightly different problem.

A sample of community leaders ranked the importance of statements about seven facets of the industrial education program in a Q-sort study by Zullinger (1968). The image of industrial education was not especially clear to the participants, who indicated a need for more adequate information about the program. Opinions obtained from a sample of industrial arts, home economics, and business education teachers indicated that industrial education had a lower-than-average status. Zullinger offered several suggestions for improving the image of industrial education and developing a systematic approach to change the attitudes of the public. Curriculum improvement was considered to be a vital ingredient of the total process.

The relative importance of the objectives of industrial arts was investigated by Backus (1968). Statements of student behavior characterizing "ideal" attitudes, concepts, skills, knowledges, appreciations, and values were used to prepare a Q-sort instrument. Industrial arts teachers, coordinators, and superintendents rated the importance of the student behaviors. On the basis of data from his study and from other recent studies, Backus compiled a priority order of perceived importance for the nine objectives of industrial arts used to prepare the statements of student behavior. The composite emphasis indicated as desirable was: (1) habits of orderly performance; (2) shop skills and knowledge; (3) drawing and design; (4) appreciation and use; (5) health and safety; (6) interest in achievement; (7) cooperative attitudes; (8) self-realization and initiative; and (9) interest in industry.

A questionnaire including 130 statements of beliefs was submitted to a state-wide sample of industrial arts teachers and teacher educators and to nationally prominent industrial educators by Kachel (1967). The three groups were in general agreement on the importance of statements dealing with objectives of industrial arts and appropriate methods of teaching the subject. The responses did not lend themselves to the identification of clear-cut patterns of belief with regard to course content and the industrial arts curriculum, or in the evaluation of student progress.

Continued interest in the assessment of the degree of consensus on the importance of objectives would appear to be justified. It is helpful to have an indication of the priorities of purposes which are espoused by representative groups of industrial arts educators. However, it would also be helpful to offer contemporary objectives as at least a portion of the available alternatives in such studies. In this way, evidence might be accumulated concerning the relative popularity of traditional and contemporary objectives--a question which is only a matter of conjecture at the present time. Researchers should also be encouraged to consider ways in which individuals might be led to restructure their orders of priority for industrial arts objectives. Such information would be most valuable if the profession is to be successful in achieving changes in instructional objectives within a generation.

### General Resources

A number of publications which have appeared during the period covered by this review are of such widespread interest in industrial arts that it is unwise, if not impossible, to categorize them into one of the sub-topics of this review. The reader who is looking for research on any one of several areas should examine them; they are, therefore, mentioned here as a convenience.

The papers and speeches from the national conventions are fundamental resource materials. The American Industrial Arts Association publishes an annual summary of selected convention addresses and proceedings (1965, 1966b, 1967b, 1968). While these are not actual session transcripts or copies of final research reports, much of the research which has been conducted in industrial arts has been reported at one or more sessions of the AIAA conventions. The Industrial Arts Division of the American Vocational Association has not issued a similar summary of presentations. However, the speeches of the 1967 AVA convention (1967) are available from the ERIC system as a part of the VT–ERIC set.

Wilber and Pendered (1967), Silvius and Curry (1967), and Littrell (1966) published general professional books covering many aspects of the industrial arts profession. The American Vocational Association produced a major revision of the perennially popular *Guide to Improving Instruction in Industrial Arts* (1968).

Terms used in defining industrial arts subjects (drafting, woods, construction, textiles, etc.) were included as a section of the revised U.S. Office of Education handbook of definitions of educational terminology (Putnam and Chismore, 1967). Schmitt and Chismore (1967) reviewed the procedures which were followed in the development of the definitions and included the entire group of definitions dealing with industrial arts. Their readily available publication should be an important source of authoritative definitions of industrial arts courses and course content.

## CURRICULUM DEVELOPMENT

Curriculum development has provided one of the major thrusts of industrial arts research efforts during recent years. An adequate and comprehensive review of each of the many efforts in curriculum development is extremely difficult to produce. The curriculum projects are dynamic efforts which have not yet published evaluative data or made many of their "in-house" publications available for general distribution at the time of this writing. The reviewers are aware of the problems associated with premature release of publications. Nevertheless, it is almost impossible to produce an up-to-date review of the "state of the art" when the review must be confined to generally available materials.

The reader should supplement his examination of this section and the similar chapters of Streichler's (1966) review by a careful examination of the relevant issues of *Abstracts of Instructional Materials in Vocational and Technical Education* (AIM) and *Abstracts of Research and Related Materials in Vocational and Technical Education* (ARM). These publications, issued by The Center for Vocational and Technical Education, provide descriptive abstracts of instructional materials and research reports, respectively. No attempt has been made to include all AIM and ARM listings in this review, since to do so would be an unnecessary duplication of effort. Parenthetically, the reviewers wish to urge researchers with relevant materials to forward them to the ERIC–VT Clearinghouse to be considered for inclusion in the ERIC document storage and retrieval system.

### Proposals for Content Selection

Content selection is basic to curriculum development in all instructional areas. This section includes investigations which have emphasized the provision of guidelines for content selection. The indefinite limits of many definitions of industry, or technology, or of occupations within either industry or technology, or whatever other basic realm is selected for industrial arts makes curriculum development somewhat more difficult for industrial arts than it is for other school subject areas.

Researchers and curriculum development specialists typically begin their work with the assumption of the existence of a definable body of knowledge, usually industry, and then proceed to select content from this body of knowledge. Dudley (1968) has published an interesting analysis of several curriculum development methods currently used by industrial arts personnel. Five generally used techniques have been identified: trade analysis, materials and forces analysis, technical orientation, interdisciplinary approaches, and conceptual analysis of the content area. Each technique begins with the assumption of a content base in either industry or an industrial occupation. The article provides an interesting analysis of the markedly different general goals, content, and methods that result from using each of the content selection procedures.

The complexity of the problems associated with content selection has been succinctly stated by Kicklighter:

> If we accept the premise that industrial arts should concern itself with a study of industry, then we must answer the question, "What is industry?" This question is not easy to answer, but it is certain that it is more than woodworking, metals, electricity, automotives, and drafting. Industry is also more than products, processes, materials, and profit. It is organization and people; but just as important, it is a major institution of our society. This is true because it affects almost every aspect of our life. . . (1967, p. 14)

Faced with the dilemma of defining and limiting the boundaries of industry and the selection of appropriate content from within the definition necessitates a carefully developed taxonometric analysis. Kicklighter argued for multiple analyses which attempt to be both universal and modifiable without destroying the original structure of the derived taxonomy. One such structure, according to the author, was based on the common elements in any large industrial organization. These common elements were its formal organization, informal organization, union organization, industrial relations, employers' organizations, production structure, research and development structure, financial organization structure, and legal structure. Two levels of specificity were included in a sample taxonomy intended to serve as illustrative of the universality of the analysis.

Concern for consistency and universality of content and selection led DeVore (1967) to a macrotechnological analysis as a possible selection strategy. The analysis attempted to identify the universe of content which was consistent with general education values and guidelines which identify discipline structures. The major technical areas of production, communication, and transportation were identified as meeting the selection criteria.

A third attempt to develop a taxonomy to insure consistent content selection procedures was developed by Hauenstein (1966). This taxonomy was developed after industrial technology was dichotomized into manufacturing (in-plant) and construction (on-site) technologies by the Industrial Arts Curriculum Project. The taxonometric analysis of the construction industries adhered to carefully defined criteria and included a syllabus of content as part of the final report. The taxonomy included major units in worker control, material handling, separating, combining, and forming practices in each of three categories: pre-processing, processing, and post-processing.

Opinion-gathering techniques were also used to provide a basis for content selection in industrial arts. Berry (1967) used a questionnaire to obtain data for content selection. The results of an analysis of opinions from personnel in selected New England manufacturing industries indicated a greater need for instruction in industrial organization, labor, finance, distribution, and sales. Kemp (1966) reported success in using rating scales and card-sorting techniques to ascertain the reactions of teachers and teacher educators regarding graphic arts course content. Wolansky (1968) empaneled a group of 24 fluid power specialists to determine appropriate content for an undergraduate teacher education program in fluid power instruction.

Stadt (1966) urged a multiple-analysis procedure in which the content for industrial arts would be derived from several aspects of productive enterprises. Possible bases included: size of the enterprise, degree of mechanization, type of institution (financial, governmental, religious, educational, or recreational), vertical integration within the organization, horizontal integration, materials processed, processes (such as mining, refining, casting, and machining), products, and location. Stadt indicated that all these factors could provide avenues for productive analysis to identify content for industrial arts.

Systems analysis procedures, originally developed to evaluate and coordinate complex military projects, were presented as a possible approach to selecting and limiting industrial arts content. Yoho (1966, 1967, 1969) contended that a total educational "system" operates in society and that this system could be "modeled" to determine appropriate content for any program at any level. The modeling procedure uses SNAP (Systems Network Analysis Process) maps which facilitate identification of a path toward action and goal achievement. The most recent publication (Yoho, 1969) presented the basic mapping procedure and provided examples at several levels of specificity for industrial arts content.

Pucel (1966) studied the effectiveness of a word-association strategy for content selection in industrial arts. The study was undertaken as a result of the successful application of this technique in other school subject areas. The method was highly student centered and attempted to make provision for the prior backgrounds of the students. Although the sample was small and some of the procedures were developmental, the author recommended the strategy as having valuable potential in an area with content that is as complex and interrelated as that in industrial arts.

### Innovative Curriculum Efforts

Dissatisfaction with contemporary industrial arts programs coupled with a great deal of effort in improving content selection and analysis procedures has led to a large number of proposals for new educational programs for industrial arts. Some of these curriculum proposals were the result of funded curriculum projects; other proposals resulted from the efforts of individuals or small groups with little or no funding. The major factor in all proposals is the emphasis upon industry in a modern technological society as the base for content selection in industrial arts. The studies included in this section represent the large number of curriculum efforts which have been undertaken by curriculum researchers in industrial arts.

The American Industry Project (Flug, 1966; The American Industry Project, 1966; Gebhart, 1968; and Nelson, 1967a) developed a taxonomically derived junior high school program. Major emphasis was placed upon the understanding of American industry. The course content and instructional materials were developed around the concepts basic to the structure of American industry.

Instructional materials were developed for three grade levels. Level I was designed for eighth grade students and included instruction designed to develop the major concepts of industry and to assist the learner to solve simple problems related to industry. Level II was designed for tenth grade students and included materials designed to develop in-depth understandings of the concepts of industry and refined understandings of the relationships among the concepts. In addition, the materials were designed to expand the students' ability to recognize and solve complex problems related to industry. Level III, for twelfth grade students, was designed to develop problem-solving skills within a cluster of industrial concept areas centered around problems of individual interest. The American Industry program has undergone field testing and revision of the content and associated instructional materials. Related activities in teacher education and expanded field testing activities are under way at this writing.

Another major industrial arts curriculum is being conducted by The Ohio State University in cooperation with the University of Illinois. This project, The Industrial Arts Curriculum Project (IACP), is developing a two-year curriculum for use in the junior high school (Towers, 1966, 1967; IACP, 1966a, 1966b, 1966c). The source of content for this project was derived from industrial technology. Industry was defined as the economic institution which substantially changes the form of materials to satisfy man's wants. Technology was defined as the science of the application of knowledge to practical purposes. The definition excluded economic activity involved in such areas as mining and agriculture, because neither area was considered to make substantial changes in the material. Once the realm of the content was established, industrial technology was divided into two basic subdivisions: construction (on-site) and manufacturing (in-plant) economic activities.

A first-year course was developed around "The World of Construction" and a second-year course around "The World of Manufacturing." Course content and instructional materials were developed for each course by the use of a three-dimensional analysis matrix. The instructional materials are, at this writing, undergoing wide scale field testing and revision. In addition, summer institutes for experienced teachers and modifications of undergraduate teacher education programs are being undertaken to prepare teachers for this new approach to the teaching of industrial arts.

Minelli (1965) developed the Partnership Vocational Education Project to function at the university, community college, and high school levels. The ninth or tenth grade, beginning program consisted of "The Study of American Industry." Content was designed for students of all ability levels and stressed the functions and interrelationships of modern industry. During the eleventh and twelfth grades the program consisted of a two-year sequence of four major courses in the subject areas of English, science, mathematics, and industrial-technical education. Three levels of instruction were geared to the ability levels of the students. All instruction utilized careful planning and team teaching, where appropriate, by the four teachers involved in the program. Additional educational advantages for those who could profit from community college or university study were included in the overall project plan.

Ziel and others (1966) reported on the first stages of a pilot study of an innovative industrial arts program. The program was developed to provide boys and girls with experiences designed to interpret "productive society." Phase I introduced tools, machines, materials, and processes in ceramics, graphic arts, plastics, woods, metals, and electricity. Results of the pilot study indicated that five groups receiving one year of Phase I instruction performed significantly better than matched comparison groups in terms of mathematics and science tests. Additionally, there was a general, though less definite, trend toward reinforcement of communication and language skills.

The total curriculum effort included four phases. Phase II was designed to introduce several technologies and their interrelationships. The technologies represented were graphic communications, testing, power, power transmission, mechanical, electrical, and computer technologies. Phase III introduced students to the functions of an industrial society. Activities included experiences which required study of organizational structures, decision making, communications, and authority configurations. The final phase (IV) provided an opportunity for students to pursue research and development tasks which resulted in a prototype or experimental project related to the content of the earlier phases.

### Implementing Curriculum Change

Proposing curriculum reforms and developing instructional materials to implement the modified program, field-testing, and revision of materials are essential stages in the process of curriculum change. Large scale implementation of new curricula requires the efforts of many people and the expenditure of substantial time and money before the new program can make substantial impact in the schools of the nation.

Maley (1967a) reported successful cooperation in the development of innovative curriculum materials as the result of the close cooperation between teacher education and the public schools. Instructional materials were developed over a 10-year span within the framework of the definition of industrial arts: those phases of general education which deal with the organization, materials, occupations, processes, products, and problems of industry. Particular emphasis was placed on the development and field testing of materials for line production and group projects. Special provisions were made to prepare teachers who could promote student experimentation and other student-centered techniques. Junior high school programs utilizing these materials were reported under way in two large suburban communities.

New content and new approaches to presentation of the content create a new problem for instructional efficiency and effectiveness. Maley (1967b) reported the problems involved in the implementation of a student-centered industrial arts program in a 6-3-3 school plan. Results of this experience prompted the author to stress the importance of developing a means of determining the students' prior attainment of certain developmental tasks. In other words, the student must also be considered as a variable in the teaching-learning process.

Two recent studies evaluated the contemporary curriculum proposals from the viewpoint of potential widescale implementation. L.H. Cochran (1968b) compared the similarities and differences between recent curriculum proposals. He indicated a tendency toward consensus among the programs regarding: (1) de-emphasis of manipulative activities with a concomitant increase in emphasis on the applications of scientific principles; (2) increased use of a multi-activity organization; (3) de-emphasis of avocational and craft orientations; (4) trends toward the elimination of materials-processing classifications as course titles; and (5) the tendency toward a "middle-of-the-road" position regarding design, craftsmanship, the use of tools and machines, and consumer knowledge. Bohn (1968) looked at the innovative proposals developed within the profession and at program modifications which have resulted from the development of commercial instructional materials and equipment for industrial arts programs. The implications of both of these major thrusts were evaluated in terms of probable curriculum effects. Specific recommendations were made for the modification of established woods, metals, and drafting programs to allow for the implementation of the newer programs.

Hastings and others (1967a, 1967b) developed a wide variety of instructional materials directly related to contemporary industrial practice. The materials were prepared as part of a special summer workshop. Workshop participants attended an orientation session, studied and observed industry, then returned to campus to write instructional materials based on their experiences in industry. The materials provided a pool of industrially-related instructional materials which would assist in the implementation of new programs.

### Status of Industrial Arts Programs

The U.S. Office of Education undertook a comprehensive study of the status of industrial arts in the fall of 1962. The results of this study (Schmitt and Pelley, 1966, 1967) provided information from a stratified random sample of public secondary schools about industrial arts programs, activities, and enrollments. Survey results indicated that approximately 40,000 industrial arts teachers were teaching nearly 4,000,000 students in grades nine through 12. Instruction was concentrated in woodworking, drafting, and metalworking. Industrial arts was being increasingly added as a required subject for both boys and girls.

Ten purposes of industrial arts were listed on the survey form used by Schmitt and Pelley. Industrial arts teachers and principals agreed that developing skill in the use of tools and machines, developing technical talents, provision of technical knowledge and skills, and development of problem solving skills related to materials and processes were the four main objectives of industrial arts. Important differences in opinion were identified regarding the objective of developing an understanding of the technical culture. The objective was rated high by teachers but low by principals. The reverse was true regarding the leisure-time objective.

Stress on skill development, as exemplified in an industrial arts award program, was evaluated by Beach (1967). The awards program was judged effective in promoting industrial education programs among the participants, but ineffective in attracting participants to industrial education teaching. Falls

(1968) found that personnel directors of manufacturing companies and industrial arts teachers disagreed about the importance of items for inclusion in exploratory courses. Teachers selected skill-related items more often and the industrial personnel elected information-related items more frequently.

Three large cities have changed their industrial arts programs to make them more occupationally-oriented. San Diego has developed programs of "occupational training" which use industrial arts teachers and laboratories to present two-hour courses in various occupational areas (Steinberg, 1966). Turnquist (1965) initiated an occupationally-based program in the city of Detroit. The program was introduced in former industrial arts classes in a limited number of schools, with course content organized around various occupational galaxies. Warren, Ohio has recently revised their industrial arts program to provide improved coordination with trade and industrial education (Williams, 1968).

The trend in these cities appears to be toward occupationally-oriented courses. The opposite trend appears to be occurring in other communities, where stress is upon more general understandings, with a de-emphasis on skill-building activities. The Syosset Plan (Hacker, 1969) was initiated to provide junior high school students with an 18-week course organized around manufacturing activities. Highly individualized, student-centered programs have been developed by Maley (1966) and McClain (1966) to stress problem-solving and student involvement in content selection. The typical content was derived from a broad definition of industry. Industrial activities such as research and experimentation and mass production were included.

Analysis of recent literature regarding the introduction of mass production and related activities resulted in an insightful criticism of current practice (Haskell and Schenck, 1966). While the literature generally advocated mass production activities, Haskell and Schenck indicated the need for a more balanced look at the social, as well as the economic and technical implications of production organization.

Changes in public school programs as a direct result of funded research have begun to appear in the literature. Blum (1968) described the teaching of the construction unit developed by the Industrial Arts Curriculum Project. Classroom activities of the American Industry Project were described by Face and Flug (1966). Kirby (1968) described the Industriology program and activities which are now a part of the industrial arts programs of participating secondary schools. Many of the materials used to teach the Industriology concept have been developed as a result of a series of Experienced Teacher Fellowship grants.

The impact of the space age has been felt in instruction in industrial arts. The National Aeronautics and Space Administration (NASA) funded a study of the aerospace industry and its relationship to instruction in industrial arts. The study resulted in noticeable changes in some industrial arts programs. Feirer and others (1967) and Latham (1967) recommended the inclusion of space-oriented study within the framework of industrial arts instruction. The implications and problems of educating children of space scientists and technicians were detailed in a description of the Nova, Florida, Technical Science Program (Wolfe, 1967).

The special needs and abilities of students of superior academic ability are beginning to become a concern of industrial arts personnel. Horn (1966) reported a program of advanced placement in engineering graphics for entering freshmen at Stout State University. The New York City Board of Education (1967), through its Bureau of Curriculum Development, has developed a curriculum guide and instructional materials for comprehensive high school eleventh and twelfth grade students who are planning post-secondary careers in engineering and technology.

## INSTRUCTIONAL MEDIA AND METHODS

Industrial arts researchers continue to demonstrate considerable interest in the problems of efficiently communicating content to learners. As a consequence, this is one of the larger sections of this review, covering instructional materials and devices, learning processes, teaching methods, and organizational variables. This grouping of studies is extremely difficult to categorize; as a consequence, the reader should consult each sub-division which might be helpful to him. Each study appears only one time in this section, under the sub-division which appears to reflect the primary emphasis of the study. Subordinate areas of investigation or comparative methodologies are indicated in the description, insofar as it has been possible to do so.

Taylor and Christensen (1966, 1967) surveyed the use of instructional media in all fields of vocational education. Their review, too, has interest for industrial arts educators in areas such as individualized instruction, packaged learning systems, television, computer-assisted instruction, micro-teaching, and audio-linkage systems. They emphasized the importance of a research effort directed toward the effective implementation of curriculum change via new media. The problems of selecting an appropriate method for teaching industrial education content were examined in a research review by Suess (1966). After commenting upon the findings of research dealing with programed instruction, visual aids, demonstrations, and other methods, Suess indicated that it would be more realistic to study the most efficient use of the many available methods rather than to search for a superior method of teaching. Research on techniques and modes of instruction in the vocational, technical, and practical arts areas was reviewed by Householder (1968). He noted that substantial research activities had not yet made significant contributions toward the development of a theoretically-oriented body of knowledge which would guide the educator in the selection of an appropriate instructional technique or method.

### Programed Instruction

The applications of programed instruction in industrial arts have not been as rapid or as widespread as in other educational areas. Articles which point to the future values of programed instruction, or which offer guidelines for the selection of programs, are, however, in evidence in the literature. Hofer (1967) reviewed the potential of programed instruction, teaching machines, and computerized instruction for industrial arts. He provided guidelines for selecting programs and recommended a pilot study with a small group of students before the large-scale adoption of programed instruction. Jelden (1968) defined the basic assumptions underlying a system of learner-controlled education and described a system being developed for use in college electricity/electronics courses.

Programed instruction has been used in a substantial number of studies in industrial arts education, even though it has not attained widespread acceptance. Most of these have contrasted the effectiveness of programed instruction with one or more other methods of content preparation. However, some research has compared specific organizational variables within the programed instruction format.

A programed lecture and a programed text were compared by Stephenson (1969). Junior high school students learned a unit on lumber measurement more efficiently from the programed text than from the programed lecture. Simich (1965) used two self-instructional methods, programed instruction and a correspondence-course technique, with seventh grade industrial arts students. Students who used the correspondence-course technique attained significantly higher gain scores on the initial learning test. However, the difference between the two groups was not statistically significant on a retention test administered three weeks after instruction. Yff (1965) presented a unit on matter, energy, and work to ninth grade students by three methods: (1) an explicit-overt response program; (2) an explicit-covert response program; and (3) an implicit-response reading booklet. The criterion test data did not yield significant treatment effects. Test performance was related to intelligence, but no significant effects on tests scores were attributable to sex difference.

An experimenter-constructed program and a conventional lecture-demonstration method were used to teach a unit on Ohm's Law and D.C. power to college students in a study completed by Francis (1966). The two methods did not yield significantly different results in terms of scores on tests of initial learning and retention. Aguirre (1966) taught engine lathe principles and operating procedures to college metalworking students by programed instruction-demonstration and by illustrated lecture-demonstration. The two methods were equally effective in developing proficiency in engine lathe operation and in terms of immediate learning and retention as assessed by an achievement test. Ricker (1965) taught the basic properties of magnetism by four methods: (1) lecture only; (2) lecture and demonstration; (3) lecture and experiment; and (4) lecture and programed learning. The methods did not produce significantly different performances on the posttests and the retention test. Ricker concluded that the lecture-only method was most productive in terms of the time demands of students and the instructor.

L. H. Cochran (1966) compared the effectiveness of programed instruction, conventional methods, and direct-detailed instruction in teaching the knowledges and skills involved in technical lettering. The programed method resulted in significantly improved performance on a test of lettering knowledge. No significant differences were identified between the groups in terms of lettering skills. The use of programed instruction to teach the safe use of hand tools was also investigated by L.H. Cochran (1968a). Programed instruction was more effective than conventional lecture-discussion instruction in the schools for which the program was written. However, the two methods did not differ significantly when they were used in a second school with a different student population.

Benson (1967a, 1968) compared the effectiveness of programed operation sheets and standard operation sheets as supplements to class demonstrations in a seventh grade industrial arts class. Students using the programed operation sheets required less assistance and acquired more technical knowledge than students using the conventional operation sheets. The two groups did not differ significantly in terms of the time required or the quality of the completed job.

Two studies compared the effectiveness of programed instruction and slides. Ballard (1966) presented information on wood joinery to college woodworking students by means of a programed text and a lecture-discussion supplemented by 2 x 2 inch colored slides. Criterion test scores indicated that the programed presentation was more effective than the lecture-discussion method, despite the fact that only 85 per cent of the programed lessons were completed.

Eighth grade students were taught to prepare and lock up a single type form by means of individually self-paced programed booklets or by 35mm slides paced by the last subject in the group to respond to the projected frame (Heyel, 1967). The two methods were equally effective in terms of immediate learning and retention test performance. Upper ability students did equally well with either method; lower ability students did better with the self-paced programed method. Group-paced subjects required less time than groups paced by the slowest individual.

Lundy (1968) presented four units of instruction on the automotive ignition circuit to high school automechanics students. Each student received a linear programed booklet for two of the units and watched sound filmstrips for the other two units. The programed booklets were most effective in terms of initial learning over the entire block of instruction; the two methods did not differ significantly, when retention served as the criterion.

The weight of the available research evidence indicates that programed instruction is indeed an effective method of teaching. Despite the appearance of a large number of studies, there has not yet been enough research to identify specific effects of programing variables, such as step size (if these are important), or to provide assurance that programs are indeed the best choice for any particular instructional need. It would appear that programs should be used judiciously, but probably much more than they have yet been utilized in industrial arts classes. Considerably more action-research will be needed before teachers are able to select and use programed instruction wisely.

### Television

The feasibility of using television for instruction in industrial arts was investigated by Dutton (1966). It was concluded that all instructional areas in industrial arts could benefit from appropriate applications of televised instruction. The report defined several critical aspects in the initial implementation of a program of televised instruction in industrial arts.

Video-tape equipment was used to present demonstrations to groups in the junior high school industrial arts laboratory in a study by Sauer (1967). The procedure was effective for group demonstrations and particularly helpful for any necessary re-teaching. In addition, the camera and monitoring equipment made it possible to keep hazardous areas, such as welding booths, under teacher surveillance even while the teacher worked with students in another setting.

Entorf (1967) prepared video-tape recordings of four units of technical information in woodworking from art cards, key cards, slides, motion pictures, and samples of materials. Experimental subjects received instruction on two units from the video-tapes and for two units from a lecture which utilized the visuals used in producing the video-taped lessons. Subjects who learned by video-tape recordings attained higher scores on initial learning and retention tests. However, subjects preferred the lecture method, and thought it covered the material more thoroughly. Some units were more appropriate for video-taping than others.

Baron (1968) used video-tape recording and live demonstrations to teach seventh grade subjects to compose and justify a line of type. Achievement test and performance data were obtained immediately after instruction and after a one-day delay. The two methods were equally effective in terms of performance on the psychomotor task and in terms of achievement test performance, with one exception: students of lower ability who received the video-tape presentation were less effective when the criterion tests were administered after a one-day delay.

Problem areas to be considered in the educational utilization of television were reviewed by Canada (1967). He discussed the necessary studio equipment which should be available and provided guidelines for the applications of visual aids. Technical constraints of the medium were discussed and specific suggestions were provided for the preparation of televised instruction.

Video-tape recordings, closed circuit television, and other applications of televised instruction are still in their infancy in industrial arts. Substantial research efforts must precede the formulation of definite recommendations which are justified by an array of empirical data. For the present, practitioners should exploit the obvious capabilities of instructional television, maintaining an evaluative attitude in each instance. Their experiences over a relatively short period of time should stimulate the development of hypotheses worthy of experimental verification. Research can then begin to accumulate a body of knowledge concerning the application of televised instruction in industrial arts classes.

### Films, Filmstrips, and Slides

These media have been available to educators for a relatively long time, yet they are the subject of renewed interest in recent industrial arts research. Closed-loop 8mm film has received unusual emphasis because of its suitability for individualized and small group instruction.

Moeller (1967) taught engine lathe operation to college students by means of individual machine demonstrations and by means of an especially prepared 8mm film with synchronized tape-recorded narration. The students using the films viewed them individually, at the work station, with control of the pacing by means of a start-and-stop mechanism. Students using films required more total time and a larger number of trials than the students who received demonstrations. The accuracy of work achieved by the two groups was not significantly different.

Flug (1967) used four self-instructional modes to teach seventh grade boys to rivet aluminum: (1) 35mm color slides; (2) slides with tape-recorded audio; (3) 8mm color closed-loop film; and (4) film with audio. The slides and the film were equally effective in terms of posttest results. Slides without audio supplement yielded poor performance from low ability students; the other modes were equally effective across ability levels. Few learners returned to the media after one viewing, even though they were encouraged to view them more than once.

Hickman (1967) presented 30 descriptive geometry lessons by lecture, printed information sheets, and 8mm single concept sound films. The results were not conclusive; the films produced test performance significantly better than the other two methods in one comparison. Information sheets were more effective in another comparison. In terms of net learning and retention, the three methods were equally effective. Lectures required more time than the other two methods, but the lectures were the least expensive of the methods to produce.

Amthor (1967) taught six principles of descriptive geometry by three methods: lecture-demonstration, silent filmstrips, and sound filmstrips. Each subject was exposed to each of the three methods. The three methods were equally effective, though the principles were not equally difficult. Students preferred the lecture-demonstration method, but suggested incorporating the filmstrips into the presentations.

College students were taught engineering drawing by sketching on the chalkboard and by 35mm slides in a study by Wilkes (1966). The two methods were equally effective in terms of the quality of the work completed. The method using the slides was more effective in terms of informational achievement, improvement of the ability to visualize, the quantity of work completed, instructional time required, and student attitudes.

Baker (1966a) taught one-point perspective drawing by means of a chalkboard lecture, by a prepared slide program, and by the same program using stereo slides. While the different presentations did not yield significant differences in initial learning, the slides stimulated interest in the subject and the stereo slides were particularly well received.

Shemick (1965) compared teacher demonstrations with a slide presentation synchronized with magnetic tape to teach metal spinning. While the demonstration method was more efficient in terms of student time required, it used more of the teacher's time for individual instruction.

### Miscellaneous Media

In addition to investigations which were readily categorized under one or another of the conventional designations for media experiments, researchers in industrial arts have investigated a number of potentially valuable areas which deserve note and comment. These include the use of assembly and instructional models, educational toys, caricature booklets, teaching systems, projectuals, and microfilmed drawings. The studies in this section should prove to be especially provocative of additional research efforts, since several of them open new areas of investigation.

Crowder (1968) found that the use of individual assembly models in conjunction with visual slides resulted in increased learning and retention of selected general shop units. The achievement of secondary school students receiving the experimental treatment was contrasted with the accomplishments of those receiving only conventional instruction. Both lower and higher intelligence groups did better with the experimental combination of models and slides than with conventional instruction.

Scale models, pictorial drawings, and no visual aids were three experimental conditions used by Bjorkquist (1966) in teaching orthographic projection to sixth-grade boys. The scale models and the pictorial drawings were equally effective in terms of learning task data; both were more effective than no visual aids. However, on a transfer task administered immediately following the learning task, subjects who had learned with models did not perform significantly better than those who had no aids, or the uninstructed control group. Students who had learned via the pictorial drawings had a higher performance level on the transfer task than any of the other groups.

Basic plastics content was presented by means of commercial plastics processing equipment and by means of three-dimensional mockups and educational toys (Steele, 1967a, 1967b). The two treatments were equally effective in developing manual dexterity. The commercial equipment method resulted in significantly higher scores on an achievement test covering knowledge, comprehension, and application.

Caricature booklets which presented safety information on six woodworking machines were developed by K.P. Anderson (1968). These were used to supplement conventional safety instruction in woodworking classes. Each experimental subject received three units of instruction by conventional methods alone and three units by conventional methods supplemented by the experimental booklets. The use of the supplementary bookets resulted in improved initial learning and retention on three of the six units. The nine teachers varied significantly in effectiveness, and teacher by treatment interaction was significant for three of the units.

Pankowski (1966, 1968) analyzed the content of four teaching systems for basic instruction in electricity/electronics. After evaluating the materials for readability, coverage of electrical principles, manipulative operations, and test equipment, Pankowski suggested the inclusion of more electrical principles, additional test equipment, and the design of a system for a specific level of instruction.

Sedgwick (1965) used a series of projectuals, overlays, and scripts to present a unit on graphic communication. Instruction emphasizing graphic communication as a basic communication medium was successfully learned by junior high school students in beginning mechanical drawing. The novel approach did not retard the incidental acquisition of conventional mechanical drawing content.

Projectuals used to supplement classroom lecture, discussion, and demonstration reduced the total teaching time required to present five units of basic electricity content, yet resulted in higher overall test performance in a study by Yeager (1968). The differences attributed to projectuals were not significant for four of the five unit tests.

R. M. Cochran (1966) described a system which combined microfilmed drawings with aperture card mountings to provide instantly useful teaching aids. Since the system is typical of the type used in industrial drafting practice, the environment in the drafting room is a truer representation of industry.

Drake (1966) prepared information sheets on technical and nontechnical content written at the tenth-grade readability level and rewritten at the fifth-grade level of readability, as indicated by the Dale-Chall formula. The two levels of readability on the two instruction sheets were equally effective in terms of comprehension, retention, and reading speed of seventh grade students.

### Creativity

A significant review of research on creativity was produced by Hahn (1968), who emphasized the application of the research in industrial arts and other practical arts and occupational education areas. After developing a definition of creativity on the basis of his review, Hahn described the array of instruments available to assist in the assessment of creativity, and discussed research on the complex relationships between measures of creativity and intelligence. In a synthesis of research recommendations, Hahn suggested that teachers could facilitate creative behavior by providing opportunities for creative behavior, establishing creative relationships with children, giving purpose to creative writing, expecting original thinking from students, and rewarding the students for ideas.

Seitz (1966) tabulated the incidence of articles on problem-solving and creativity in six industrial arts periodicals during the periods 1940-1944, 1950-1954, and 1960-1964, inclusive. Both problem-solving and creativity were mentioned with sharply increasing frequency during the three periods. The articles indicated increased understanding and acceptance of problem-solving and creativity in industrial arts programs. Seitz noted a trend toward the use of industrial arts facilities as laboratories for encouraging creative planning, experimentation, and construction.

Recent research relative to creativity in industrial arts appeared to be of two types: studies which dealt with attempts to improve various aspects of creative performance, and studies which attempted to assess the influence of creative abilities upon academic performance. The two types of research are quite similar in many obvious respects, yet their theoretical assumptions are substantially different.

Two studies reported on successful attempts to improve creative performance levels. Harney (1967) modified college courses in crafts, wood technology, and metal technology to include materials intended to encourage creativity and design judgment and to provide freedom in design decisions. The performances of students enrolled in the modified courses were compared with those of students in the conventional counterpart courses. In two of the three comparisons, performance on a test of creative ability was higher for the experimental subjects; they also attained higher achievement test scores in one of the courses. Harney concluded that it was better to encourage general creativity by using a problem-solving teaching approach in preference to a more restrictive conventional approach.

Hanks (1966) presented a college industrial arts design course under two conditions. The first employed minimal restriction, with considerable freedom in the selection of design problems; the second utilized maximal restriction, where specific design problems were assigned. On a posttest of creative ability, students who had been minimally restricted produced significantly more creative ideas than did the students who had worked on the assigned design problems. Hanks concluded that idea productivity might be stimulated by providing experiences in identifying problems and refining ideas.

Specific, controlled variations in instructional media characterized an investigation in the development of creative expression by Magowan (1967). Self-instructional booklets on creative design were used to present design problems to college students in two modes: pragmatical problems, which required utilitarian products for solutions; and hypothetical problems, which required solutions for imagined products. No significant differences were obtained in terms of aesthetic awareness, quantity of ideas, or number of unique ideas when the over-all results obtained by the pragmatical and hypothetical approaches were compared.

Two closely related, but independent, research studies (Moss and Duenk, 1967) attempted to determine the relationships among different performance measures of figural, behavioral and symbolic creativity, teacher and peer ratings of creativity, scores on creativity tests, academic aptitude, achievement in various subjects, and certain student personality characteristics. Neither study yielded high zero order or multiple correlations, but it was shown that creativity cannot be treated as a unitary ability and that measures of creative aptitude must be distinguished from measures of creative performance in real situations.

At the high school level, Mietus (1966) developed a special program designed to provide an opportunity for creative expression for technically inclined boys who were not motivated by traditional school subjects. The 16-week course, taught by seven teachers, was effective in improving student scores on a test of creative abilities. Students who had completed the special course demonstrated higher scores than control group students on the flexibility, dominance, and femininity scales of a personality inventory. Scores on conformance and self-acceptance were higher for the students in the control group. Mietus concluded that industrial arts courses intended to produce desirable effects upon cognitive and affective behaviors should be designed to provide for creative expression rather than to emphasize industrial materials and processes.

Irvine (1968) studied the relationships between creative thinking ability and the psychomotor abilities, vocational aptitude, and mechanical reasoning ability of high school seniors enrolled in industrial arts. The Torrance Tests of Creative Thinking, the Differential Aptitude Mechanical Reasoning Test, and the General

Aptitude Test Battery provided data. The components of creative thinking were not significantly related to vocational aptitudes, psychomotor abilities, or mechanical reasoning ability. Significant relationships were found between the figural dimension of creative thinking ability and spatial aptitude, and between verbal flexibility and achievement in industrial arts.

Hahn (1967) taught high school students to use the micrometer by means of programed instruction and directed discovery presentations in an attempt to evaluate the effectiveness of using instructional methodology closely related to the identifiable differences between individuals. The achievement of groups who attained high scores on the Minnesota Test of Creative Thinking, Abbreviated Form VII, was compared with the achievement of groups identified as having low creative ability. On the basis of tests of initial learning, retention, and transfer, there were no significant differences between the two methods of teaching for either of the groups. No interaction effects between creative ability and experimental treatments attained significance.

Creativity is a complex process, subtle and sometimes surprising in the inter-relationships among its components. The research interest in the area of creativity noted by Streichler (1966) has continued and expanded. The studies cited above provide some provocative glimpses into potential ways of improving creative performances in the industrial arts setting. These should certainly be subjected to additional experimentation so that curricula will be developed in ways which will stimulate creativity rather than inhibit it.

### Activity-Oriented Techniques

Industrial arts has traditionally been concerned with laboratory activities, yet most of the research on the teaching-learning process in industrial arts classes has been concentrated in cognitive areas. This is reasonable, since the assessment of manipulative performance is much more difficult than the scoring of objective tests. Consequently, there has been a scarcity of evidence to indicate the degree to which one should provide manipulative activities in industrial arts classes and almost no evidence to guide one in selecting a method for providing experiences of a manipulative nature.

In a study by Clark (1967), junior high school boys were taught to bend electrical metallic tubing, with video tape as the presentation medium. One group practiced the activity, while the other group conceptualized how to do the activity. The group with overt practice out-performed the group which had only conceptualized the activity. Several ability factors, especially motor skills ability and spatial perception, were identified as related performance achievement.

Schuler (1966) investigated the effect of laboratory techniques upon achievement in a college class in basic electronics. All subjects were given the same lectures and demonstrations, then provided two types of laboratory experiences. The group which used circuit boards with premounted components and solderless connectors demonstrated higher test performance and had a more positive attitude toward their laboratory experiences than their counterparts who used comparable circuits conventionally constructed on a metal chassis. The two groups did not demonstrate significantly different performances in terms of manipulative skills or trouble-shooting skills. Using a similar group of subjects, Baker (1966b) contrasted the use of a problem-solving approach involving the construction of individual projects without required laboratory attendance with the use of required teacher-planned projects and circuit board exercises. The students in the beginning college electricity course preferred activities which resulted in useful articles. However, there were no statistically significant differences in the acquisition of factual knowledge or manipulative skills, or in attitudes toward the course.

Ellis (1966) contrasted the construction method of drawing and the workbook method of teaching drafting in a college course. The groups receiving the two instructional methods did not differ significantly in terms of gain scores on tests of informational achievement, understanding of spatial relationships, or attitude toward drafting. Students who learned by the workbook method developed a higher mean gain in drafting skills than the students who learned by the construction method.

The effectiveness of two methods of teaching college level descriptive geometry was compared by E. J. Beck (1968), who contrasted the traditional approach, which asks students to attempt problem solutions without written or graphical analysis, with a directed problem analysis approach in which the students attempted to identify the steps in solutions and sketch tentative solutions to the problems. The two approaches to teaching descriptive geometry resulted in similar levels of gain in informational achievement, in improvement in graphic problem solving ability, and in retention of cognitive content.

Keseman (1967) studied the effect of evaluation approaches upon acheivement in a college drafting course. A student self-evaluation approach required the student to compare his work with a projected transparency solution and to record his evaluation. Two instructor evaluation approaches were used, one in which 25 percent of the assignments were graded, and the other in which all assignments were evaluated by the instructor. The three methods were equally effective in terms of advancing informational achievement and developing drafting skill. The student self-evaluation approach required less instructor time than the other methods, and the students completed their assignments faster when they did their own evaluations than when the instructor evaluated the assignments.

Thieme (1965) integrated industrial arts construction activities in the classrooms of fifth grade students. Achievement in map skills and work-study skills was measured at the end of the fifth grade and at the start of the sixth grade. No significant achievement differences were noted between groups receiving traditional instruction and those receiving supplemental industrial arts instruction and construction activities. Contrasting findings were reported by Downs (1968), who reported an experiment with three methods of instruction in a fifth grade science unit on birds. One group participated in a constructional activity directly related to the unit, another group participated in a constructional activity related to mathematics, and a third group used no constructional activities. The highest gain scores were achieved by the group which participated in the constructional activity directly related to the science unit; they also learned and retained mathematics as well as the group whose constructional activities were in mathematics. Pershern (1967) found that industrial arts activites used to supplement science units in grades four, five, and six resulted in improved achievement in limited instances. Students and teachers favored the inclusion of the activities.

It would appear that industrial arts activities may be used in elementary school classrooms. However, the teacher cannot be sure that achievement in other subjects will improve. Perhaps factors other than achievement should determine whether to include construction activities, at least until the evidence is more clear-cut.

### Specificity of Direction and Control

Brenner (1968) compared the effectiveness of two methods for teaching basic electricity content at the college level. Under directed discovery conditions, students were requried to design a laboratory procedure to solve a problem or prove electrical relationships. In the direct-detailed conditions, students were required to follow highly structured procedures in completing laboratory exercises. The directed discovery approach was significantly superior to the direct-detailed approach in terms of performance in solving electrical problems, but the two methods were equally effective in terms of immediate learning and retention, and in the influence upon student attitudes toward basic electricity.

Luck (1966) taught automotive topics to senior high school students by a direct-and-detailed method and by a directed-discovery method of teaching. Comparisons of achievement on initial learning and transfer tests were contrasted across three levels of intelligence for the experimental subjects. No statistically significant differences between the direct-and-detailed and the directed-discovery methods were identified in the comparisons. Brudzynski (1966) found the lecture-demonstration method slightly superior to the inductive method in teaching a unit on electricity and magnetism to fifth and sixth grade students. The differences attributable to instructional method did not retain significance on a retention test.

The value of informing students of the reason for instruction was demonstrated in a study of the effect of prior knowledge of the objective of the instruction. Doty (1968) reported that students who were told the reason for instruction on resistor color codes received significantly higher achievement test scores than students who were not told the objectives of the instruction.

Teel (1967) used two methods of instructing college students in a basic electricity-electronics course: the contract method, involving a written contract; and the traditional method, involving lectures, discussion, laboratory exercises, and group and individual projects. On a criterion test over the fundamentals of electricity-electronics, the students receiving traditional instruction attained higher scores than those students who had learned through the contract method. Most students had a positive attitude toward the contract method, and many indicated that they liked the sense of responsibility they felt with it.

Teachers of industrial arts are still without proven generalizations concerning the degree of specificity which they should provide in their instructional presentations. The findings of the research cited above, as well as that reviewed by Streichler (1966), did not indicate superiority for any level of detail in instructional presentations. The influence of the large number of intervening variables in experiments concerning the appropriate level of detail has apparently made it impossible for researchers to identify differences, if real differences do in fact exist.

## Achievement Determinants

Researchers in industrial arts, like those in other disciplines, have manifested considerable interest in the identification of factors which interact with instructional methods to determine educational attainment. A wide range of abilities, aptitudes, and interests have been investigated, as well as the influences of such diverse factors as test difficulty and classroom procedures.

Poucher (1968) investigated the relationships between performance on a power mechanics achievement test and laboratory grouping techniques, SAT scores, and personality and biographic variables. Gain on the power mechanics achievement test was significantly correlated with SAT verbal and mathematics scores, occupation and education of mother, length of employment, and Edwards Personal Preference Schedule deference and intraception component scores. Grouping students into adjacent and non-adjacent work pairs on the basis of pretest results did not yield significant educational advantage.

The possibility of using measures of physical maturity as predictors of success in junior high school industrial arts was investigated by Bortz (1967). In general, the relationships between the independent variables and actual performance of manipulative tasks were not significant.

The achievement of college men and women enrolled in engineering drawing was studied by B. H. Beck (1967). Men attained significantly higher achievement than women in the acquisition of technical information and in manipulative skill development. There were no significant differences between the sexes in terms of drawing performance time, the visualization of spatial relationships, and attitude toward engineering drawing.

Erickson (1966, 1967) investigated the interrelationships of the visual-haptic aptitudes of students and teachers in a beginning junior high school mechanical drawing course. Achievement on an independently constructed objective mechanical drawing achievement test was found to be related to both the students' and the teachers' visual-haptic aptitudes. Visually-oriented students were the highest achievers; the most effective mechanical drawing teachers were non-visually oriented.

Vogel (1968) prepared a comprehensive examination over electricity content commonly taught in the junior high school and administered the test to students taught by 20 teachers. Using student achievement test scores as the criterion, statistically significant differences in teaching effectiveness were found between teachers. Information about teaching methods, instructional materials, and classroom procedures used in teaching the content was obtained from the teachers. None of these identified variables proved to be significantly different.

A battery of tests designed to evaluate 10 components of manipulative ability was administered to 160 senior high school boys by Thomas (1968). When tests of manual dexterity and finger dexterity were used as criteria, subjects who had completed woodworking or metalworking courses scored significantly higher than subjects who had no industrial arts. Subjects with two years of industrial arts attained higher scores on tests of wrist-finger speed and aiming than did subjects with no industrial arts. The groups did not differ significantly on the remaining six variables: response orientation, armhand steadiness, multilimb coordination, speed of arm movement, reaction time, and control precision.

The effect of test difficulty upon informational achievement was investigated by Daines (1968). One group of college power mechanics students received a series of four unit tests which consisted of items identified as of high difficulty; the other group took tests composed of items with low difficulty levels. Students who took low difficulty tests demonstrated significantly higher informational achievement during the course than did the students who received the difficult tests. The differences between the two testing approaches were most marked for high ability students.

The reviewers have not included substantial comments about most of the studies dealing with instructional media and methods for several reasons. A high percentage of the findings of the reported research seems to be tentative at best. Replications or near-replications have not produced consistent findings in many instances. It seems to be most appropriate to withhold judgment in these areas until the evidence is clear, without discouraging practitioners from utilizing media, yet not advocating the application of methods which have not proven their superiority.

The selection of problems for investigation has proceeded without obvious pattern. The relationships between studies frequently are so hazy that it is impossible to ascertain when researchers are attempting to supplement the work of others. In many cases, studies do not seem to be related either to a theoretical structure or to another research effort. While such action-research may be quite useful in the classroom, it does not contribute significantly to the accumulation of a body of verifiable knowledge—the long-range goal of research.

In many of the studies reviewed, there is substantial evidence to indicate that all reasonable attempts have not been made to control the extraneous variables influencing the outcomes. Experimental designs frequently failed to include an untreated control group, and often used inappropriate sampling techniques. In almost every case, the duration of the experimental treatments is so short that no meaningful long-term results could reasonably be expected to occur.

In all studies which compare instructional media or methods, the researcher faces the problem of determining the relative efficiency of the experimental treatments in the frame of reference of all possible similar treatments. For example, readers and reviewers are unable to determine whether the programed instruction used in a particular study is outstanding, good, or poor in terms of its effectiveness as an instructional presentation. Ideally, comparative studies of teaching methodologies and instructional media should utilize the best identifiable examples of each of the media or methods.

In order to identify the "best" sample from a population of media, say films dealing with a specific process, the researcher would first need to engage in continuing development-evaluation-development sequences until he and/or his consultants could no longer modify the film in ways which resulted in improved student learning. After following the same procedures with, for example, a lecture, the study could then compare the best lecture and the best film in terms of their effectiveness as measured by student performance on an achievement test.

In summary, it should be noted that research on instructional media and methods in industrial arts has the potential to be of immense value to the classroom teacher. As improved research techniques are applied to the concerted study of carefully selected and delimited problems, it should become possible to provide sound, empirically-based guidelines for the selection of optimum teaching procedures for specific learning situations. This is not yet the case.

## STUDENT PERSONNEL SERVICES

The student personnel studies dealt with the guidance function of industrial arts and explored the educational problems of the dropout or the potential dropout. Three exemplary studies were selected for review here.

The lack of appropriate guidance material led Young (1968) to develop an interest inventory for the construction industries. Separate scoring scales were devised for evaluating the interests of junior high school students in construction management, construction production, construction personnel, and construction industry technology. In the norming study, students indicated the highest interest in construction production practices, followed by management practices and personnel practices, respectively.

A carefully conceived program of laboratory interaction was developed to counteract negative reactions to the busing of minority group children to under-utilized, predominantly white schools in New York City. The plan, reported by Newmark and Garry (1966), included a combination of sociometric analyses and deliberately structured group activities throughout a series of experiences. Group activities were introduced to promote the development of new friendships, to emphasize the interdependence of people, and to introduce the concept of group activity as an important factor in industrial production. These sociometric and guidance procedures resulted in highly positive reactions by the students and their teachers. Particular improvements were noted in the adjustment of individuals who were formerly "isolates" and who developed the capacity to work closely with others. The techniques were so successful that many of the teachers indicated that they intended to introduce similar techniques in their regular courses.

Matched groups of high school students in academic curricula, the industrial arts curriculum, and vocational curricula were studied by Gadbois (1967). The vocational curricula and the industrial arts curriculum demonstrated greater holding power than the academic curricula, particularly in the retention of students who had high measured potential for dropping out of school. Differences between the industrial arts curriculum and the vocational curricula were too small to justify a preference for one of the curricula in terms of its contribution to the holding power of the school.

The Gadbois study indicates a provocative area for additional research. If industrial arts were to demonstrate improved holding power over other subject areas, its place in the curriculum would be placed upon firmer ground than it has ever been.

The few studies included in this section were selected to indicate the potential importance of guidance services in industrial arts classes. There is a need for the development of a wide variety of useful interest inventories; Young has provided a worthy example for future researchers. Industrial arts educators and researchers will want to explore the type of positive attitude changes effected by guidance techniques in the potentially explosive situation reported by Newmark and Garry. Specific casual relationships in the prevention of dropouts need to be identified. The Gadbois study should justify a more detailed investigation of variables associated with industrial arts programs and their influence upon the holding power of the school.

## FACILITIES AND EQUIPMENT

There has been a continuing effort to develop guides for planning industrial arts facilities. The U. S. Office of Education (Schmitt and Taylor, 1968) published a planning guide based on a study and analysis of current industrial arts curriculum trends in the elementary and secondary schools. The guide reflected the opinions of school planning experts, state and local supervisors, and state planning bulletins, and the findings of selected research studies. Wagner (1966) developed a guide for use by architects, teachers, and school administrators in planning facilities. The American Industrial Arts Association (1967a) has also published a planning guide and equipment specification list. These three documents should provide valuable assistance in facility planning; however, it must be remembered that even the best research and recommendations based upon present needs cannot adequately provide for future developments which may not be identifiable from present practices.

A question which has been debated frequently, but seldom studied, was investigated by a researcher using a modern research technique. Work sampling procedures were used to determine the utilization of metalworking equipment in an industrial arts laboratory (Ross, 1966). While important differences in machine utilization rates were reported, the high incidence of inoperative equipment during the data collection made it impossible to develop valid utilization data which would provide accurate bases for establishing priorities for the selection of equipment. Additional research is needed before one generalizes from the Ross study, yet the observer is tempted to hypothesize that industrial arts equipment is idle for a very large proportion of its useful life. Perhaps it would be possible to develop more efficient procedures for equipment utilization if research were conducted to identify actual equipment needs in a representative sample of laboratories.

Industrial arts educators have demonstrated concern about the health hazards resulting from the contamination of the air in laboratories. No studies were identified which dealt with the reduction of contamination due to fumes or gases in the laboratory atmosphere. However, Worthington (1967) investigated the variations in air pollution caused by the presence of particles in ventilated and in unventilated laboratories. The air in the sample of ventilated laboratories was found to contain fewer particles than the air in the unventilated laboratories studied. As an interesting sidelight, Worthington found significant variation in the particle concentration in ventilated laboratories. Similarly, some unvented laboratories exhibited significantly lower particle concentrations than other laboratories without ventilation. While these findings would seem to be predictable, it would appear that this study could well serve as a stimulus for the development of other types of studies dealing with the variety of health and safety hazards in the industrial arts laboratory.

As researchers investigate variables related to laboratory facilities and equipment, they should continue the attempt to obtain objective data required for intelligent planning and operation. In this general area of problems, the "basic" research is within the realm of science or engineering, but the application of basic research to the industrial arts setting is an appropriate area of study for industrial arts researchers. The use of actual performance data to test hypotheses derived from appropriate theoretical structures or scientific evidence should result in the improvement of classroom and laboratory facilities and equipment.

## TEACHER EDUCATION

A substantial number of studies have considered a variety of problem areas dealing with industrial arts teacher education. This section does not include studies which dealt primarily with the specific problems of instructional methods for teaching courses in teacher education; such studies were reviewed in the section on instructional media and methods. Of the studies reviewed in this section, several explored various aspects of the organization and administration of the total program of teacher education, including fundamental assumptions and points of view. Several other studies were concerned with the undergraduate program. One group of studies sought to identify or validate content for undergraduate technical courses. The recruitment of teacher education students was studied by several researchers. A fifth group of studies dealt with graduate study in industrial arts.

Jacobsen (1966) and Bartel (1966) provided comprehensive reviews of research which focused on industrial arts teacher education. Their works, in addition to the earlier edition of this publication (Streichler, 1966), provide a historical perspective for the studies on industrial arts teacher education cited in this section.

### Organization and Administration

The proper administrative arrangements for industrial arts teacher education programs were discussed in a forum-type journal issue. Evans (1967) contended that industrial arts teacher education programs should be administered in the same departments with trade and industrial teacher education programs. He argued that separate teacher education departments promote an undersirable degree of specialization in terms of courses, staff, and research activities. The need to prepare teachers and administrators who are competent both in industrial arts and in trade and industrial education was cited as evidence that the colleges should provide an administrative structure which would provide for appropriate coordination between the activities of faculty specialists in the two fields. While he did not minimize the differences between similar facets of industrial arts and trade and industrial education, Evans maintained that the coordinated organization was quite appropriate and advocated that the department be extended to include all vocational, technical, and practical arts education in one administrative structure.

McMahon (1967), on the other hand, argued that the two teacher education programs should be administered separately. He posited four points: (1) vocational industrial teachers-in-training are a select group; (2) trade training cannot be replaced by laboratory training; (3) the trade and industrial teacher is already a contributing member of a community; and (4) vocational teachers are selected for probable success in teaching trade skills. He argued that industrial arts and trade and industrial education have different objectives and that the experience of the trade teacher must be acquired under actual working conditions. Since it would be difficult, if not impossible, to provide these conditions under an arrangement which placed the two teacher education specialities in close proximity, McMahon indicated that it would be wiser to place the two programs in separate departments.

In their respective discussions of the Evans and McMahon articles, Hammond (1967) explored the possibility of cooperative relationships between the two teacher education specialities, and Randleman (1967) emphasized the need for communication between mutually supportive programs of teacher education in industrial arts and trade and industrial education. It should be noted that the issues raised by the four articles cited in this section have been perennial ones. Unfortunately, the reviewers did not find any objective evidence that any organizational scheme has demonstrated substantial advantages over its rival(s). Researchers would do well to explore the possibility of obtaining data to test one or more of the hypotheses described above.

Personnel practices are important features in the organization and administration of industrial arts teacher education programs. College industrial arts department chairmen provided information on the personnel practices they employed and their evaluations of the relative effectiveness of those practices

(Hammack, 1967). Data were also obtained from faculty members who were newly appointed, who had recently resigned, or who had remained in their positions for at least five years. The three groups of faculty members were generally satisfied with their participation in decision-making, and with the personnel services, physical facilities, and faculty benefits provided at their institution. Faculty morale would have been positively influenced by improved communication, by the provision of facilities for research, and by salary improvements. Chairmen of large departments were more likely to employ faculty participation in decision-making and to consider it an effective practice in their establishment of personnel programs.

Underlying assumptions, frames of reference, and points of view are important considerations in the design of programs of industrial arts teacher education. Stadt (1969) provided a brief outline of an innovative undergraduate teacher education program within the frame of reference of his analysis of the function of the formal school and the appropriate criteria for evaluating theories of industrial arts. He indicated that prospective teachers should complete course work in the social and behavioral sciences: sociology, psychology, economics, and management. Their technical specialty courses should be organized under the categories: visual communication, materials and processes, energy conversion and power transmission, and electronics and instrumentation. In addition, Stadt recommended that prospective teachers should complete a sequence designed to integrate and synthesize the content on man and technology, and to prepare the individual for educational decision-making.

Trends in education, in industrial arts, and in teacher education were reviewed by Moss (1969). He proposed a teacher education program for the near future, with the collegiate work divided into four broad segments: general education, problems of educational practice, role of occupational education as part of the public educational enterprise, and techniques of occupational education. He suggested instruction in methods of occupational education, psychological and sociological aspects of work, technical content of occupations, and teaching practicums. In addition, he proposed that the teacher education program should include instruction on career development theory, manpower policy, and the history and philosophy of occupational education. The Moss proposal is unusual in that it suggested a change from industrial arts teacher education to the preparation of teachers who are specialists in occupational education.

An unusual approach to the organization of the teacher education program was advocated by Sedgwick (1966). He developed a two-dimensional model of desirable teacher behaviors from an analysis of interview data and from a review of the literature. Two categories of behaviors were based upon the source of the recommending authority; thus, the behaviors were either supported by opinions or by empirical data. The criterion of modifiability determined the second dimension of the model; that is, behaviors were classified as modifiable or not modifiable. A teacher education program would focus upon the modifiable behavior patterns. Sedgwick proposed a continuing, six-semester professional seminar and teaching lab designed to provide the professional teacher education program. As such, it would include the substantive information in professional education and offer the teacher education student an opportunity to experience controlled, small-group teaching early in his college career.

The studies cited in this section provide ample evidence that organizational and administrative patterns for industrial arts teacher education are in a less than determinant position. As in most areas of educational administration, the patterns of organization appear to have greater or lesser advantages, with few clear-cut distinctions favoring one approach over another. As the protagonists of each point of view collect performance data on their favored approach, it may be possible for useful generalizations to be developed. With such guidance, it should be possible to generate meaningful programs to evaluate one or more of the innovative approaches and to contrast them with traditional approaches in a variety of teacher education settings.

### The Undergraduate Program

The most fundamental portion of the industrial arts teacher education curriculum is undergraduate program. A number of studies have been directed at specific aspects of undergraduate study in industrial arts, but few researchers have attempted broad-scale assessments of the total programs.

Students who were majoring in industrial arts teacher education demonstrated a generally positive, continuous pattern of professional growth throughout the undergraduate career (Mooney, 1967). Student teaching and certain professional courses most closely aligned with industrial arts teaching produced the most substantial patterns of professional growth. Students who had completed student teaching exhibited professional viewpoints which were related closely to the viewpoints of industrial arts teacher educators. The opinions of supervising teachers, second-year industrial arts teachers, and other college industrial arts students differed substantially from the viewpoints of the teacher educators and the students who had completed student teaching.

Wargo (1968) administered an instrument for testing attitudes toward achievement to a sample of undergraduate industrial arts students. He found that students who had high grade point averages possessed attitudes which were oriented more toward effort than luck; students with low grade point averages demonstrated different attitudinal patterns. Students who had not entered college directly from high school differed from their peers in terms of attitudes favoring effort rather than luck, control over acceptance, and effort instead of ability. Three of the six scales of the attitude instrument were used in addition to class level and professional memberships as contributing variables in a formula to predict college grade point average. This study appears to open a fruitful area for further investigation and to offer suggestions for counseling prospective industrial arts teacher education students.

The accreditation of undergraduate industrial arts teacher education programs was explored by Biggam (1967), who developed and proposed a set of quantitative and qualitative accreditation criteria. He recommended that the professional associations should establish minimum criteria for teaching staff, curriculum, graduation requirements, physical plant, equipment, budget, library, and research facilities. Accreditation procedures developed by the profession were advocated by Biggam as an important method for the improvement of undergraduate programs.

Vaughan (1967) recommended a four-year curriculum for industrial arts teachers in Manitoba based upon his comparison of existing Canadian programs and the suggestions of industrial arts educators. He pointed out the confusing picture in teacher certification, which differed substantially among the provinces. Teacher education programs in Canada were found to be quite similar except for the area of specialization.

Industrial arts teacher education has been relatively slow in moving toward the incorporation of such techniques and media as micro-teaching and video tape recording in undergraduate courses. As a natural consequence, there has been a paucity of research in this area; and the available studies are quite exploratory in nature. A conceptual scheme for utilizing micro-teaching techniques in the industrial arts teacher education laboratory was outlined by Sedgwick and Misfeldt (1967). They outlined a program which provided video taped micro-teaching sessions as a continuing part of the undergraduate program. Miller and Miller (1968) reported the utilization of Flanders' interaction analysis approach in combination with video tape for presentations made during the student teaching experience. After the student teacher's presentations were video taped, the supervisor and the student teacher analyzed the teaching performance objectively and then critiqued the session.

### Course Content Selection

Several types of research have been directed toward an objective assessment of the appropriateness of the technical content included in industrial arts teacher education courses. These studies are categorized here in terms of the method used to establish the validity of the content.

In some instances, researchers have studied the techniques utilized by practitioners in an industrial specialty and contrasted the industrial procedures with those in use in teacher education. Hoover (1967) obtained rankings of the frequency of industrial utilization of metalworking processes. He found that the collegiate instructional programs provided an inadequate coverage of industrial metalworking practices, with only very limited lecture presentation of many of the more recent processes. Singletary (1968) analyzed the technology of metal finishing on the basis of published materials and obtained data on metal finishing instruction in industrial teacher education programs. He concluded that the metal finishing materials and processes currently in use were not adequately covered in courses available at the teacher education institutions studied, despite the availability of satisfactory resource materials. In a study of woodworking materials and processes, Gerber (1966) found that the majority of college woodworking courses used instructional practices similar to those used in the wood furniture manufacturing industry.

It is interesting to note the disparity of the findings in studies which compare the utilization of procedures in industry and their inclusion in courses in industrial arts teacher education curricula. One might hypothesize that instruction in college courses will lag substantially in areas where industrial technology is advancing with rapidity. In fact, it would appear that one should expect college industrial arts courses to approach the study of industrial processes in ways which would be somewhat different from the utilization of the processes in the industrial setting. In the one instance, the purpose of the activity is production; in the other, instruction.

One possible way to avoid the necessity for duplicating industrial facilities in the teacher education laboratory is to send the student into the industrial setting to obtain his experiences directly. A comprehensive program for industrial field study for industrial arts teachers was developed and field tested by Hastings and others (1967a, 1967b). The curricular model which was developed included a one-week orientation seminar covering industrial psychology, sociology, and economics; industrial and labor history; and industrial organization. Students then went into industry for a six-week period of on-site observation of industrial relations, engineering, production, labor, financial control, and marketing. Following the industrial experience, they returned to campus for a two-week workshop in curriculum development. A substantial array of resource materials were developed and are included in the final report of the project.

Individuals who head departments of industrial arts teacher education and teacher educators provided reference groups for the evaluation of course content in two studies. Davis (1966) found that the department heads agreed upon the importance of instruction in power as a part of the industrial arts program. Actual instructional emphasis was found to be moving slowly away from auto mechanics toward a broader exploration of all areas of power generation and transmission. Department heads, teacher educators, and industrial arts teachers expressed their opinions on the importance of undergraduate requirements in physical sciences in a study by Coleman (1966). There was agreement upon the importance of physical science principles, with emphasis upon physics. Many of the teachers considered their own preparation in science to be inadequate. Coleman formulated recommendations for at least 12 semester hours of required undergraduate experiences in physical science, which included relatively more physics than chemistry.

The available studies do not indicate clear-cut trends in the content of courses in industrial arts teacher education programs. However, it is apparent that commendable attempts are being made to provide a research base for the content of the undergraduate curriculum.

### Recruitment

The chronic shortage of industrial arts teachers has led to several recent attempts to assess possible ways to improve recruiting methods and increase enrollments in industrial arts teacher education. Erickson and Suess (1968) interviewed undergraduate industrial arts teacher education students to obtain their recommendations for approaches which would attract individuals into industrial arts teaching. On the basis of the replies received from the students, the high school industrial arts teacher was identified as the individual who had the best opportunity to influence high school students. The high school industrial arts teacher was considered to have the greatest responsibility for improving the image of industrial arts, establishing student clubs, developing stimulating courses and laboratories, and informing guidance staffs about the goals and purposes of industrial arts.

Heads of departments of industrial arts teacher education reported that their most frequent recruiting activities were guided tours of campus industrial arts facilities, the distribution of literature, and speeches about industrial arts teaching (Foley, 1967). Department heads were not in agreement concerning the effectiveness of the various techniques they were using in an attempt to recruit high school and college students. Foley found that the parents and high school industrial arts teachers of the college industrial arts majors had influenced them to prepare for a career in industrial arts teaching. Hobbies, high school industrial arts courses, and visits to college industrial arts facilities were experiences which were likely to exert a positive influence toward the selection of the college industrial arts major. The college students were anticipating a professional career which would offer them personal satisfactions, the opportunity to contribute to others, and a satisfactory style of living.

College industrial arts majors provided information about their career choices in a study by Ressler (1966). While the majority of the students had entered college directly from high school with an intention to enter industrial arts teaching, two large minorities were identified: 42 percent of the students entered college expecting to pursue other majors, and 29 percent of the students did not enter college directly from high school. The person most influential in affecting the decision to enter industrial arts teaching was the high school industrial arts teacher, whose influence was greater than that of parents, friends, and counselors. Eighty-one percent of the students had taken high and metals the subjects most frequently taken. The data obtained from college industrial arts majors permitted the identification of 84 high school industrial arts majors permitted the identification of eighty-four high school industrial arts teachers who had demonstrated effectiveness in recruiting students for industrial arts teacher education. These successful recruiters were more likely to be older, career industrial arts teachers who were better prepared academically and professionally more active than the average of teachers from a stratified random sample. Young, inexperienced teachers, and teachers with emergency certification, were unlikely to influence their students to make positive choices of industrial arts teaching as a career. Ressler developed a projected program of industrial arts teacher recruitment, including both short-range goals and long-term objectives. His specific suggestions for recruitment activities were based upon the data obtained in his survey of undergraduate students; the responsibilities of professional organizations and of teacher education institutions were listed in detail.

A group of classroom teachers participated in recruiting efforts aimed at introducing prospective students to the program and facilities of a major southwestern university (W. J. Anderson, 1966). These efforts were evaluated in an attempt to improve the effectiveness of the recruiting program in the future. Results of a survey of the students involved indicated an improved attitude toward the possibility of industrial arts teaching careers after the program.

One common thread runs through the reports of research on the recruitment of industrial arts teacher education students: the high school industrial arts teacher is the key person in influencing young men to consider industrial arts teaching as a career. Subsequent research efforts should focus upon methods for the identification and development of industrial arts teacher-recruiters. If the need for teachers is critical and if certain individuals are effective recruiters, it follows that it should be possible for research to identify the techniques or attributes which are pivotal. The profession could then concentrate its efforts upon the provision of such techniques or attributes. The results of such a recruitment campaign would also be amenable to evaluation.

**Graduate Study**

A comprehensive national study by Miller and Ginther (1965) reported current practices for providing graduate work in industrial arts. The development of specialized competencies and provisions for general or liberal education were studied as parts of the total graduate program in industrial arts at the institutions surveyed. Industrial arts teachers and supervisors and college department heads and deans were surveyed by Gavin (1968). The respondents recommended that a master's degree program for industrial arts teachers should assign high priority to the development of teaching proficiency with new methods, materials, and approaches to industrial arts. The educators felt that the majority of the course work in the master's degree program should be devoted to professional and technical skill courses in industrial arts, yet they recommended a degree of flexibility in the requirements of graduate programs.

Graduate credit for technical courses has frequently been an issue in industrial arts teacher education in the past. It would appear that a degree of consensus may be appearing, however. Spence (1966) found that most teacher education department chairmen favored the development of graduate level technical courses; approximately two-thirds of the 107 departments responding to his survey indicated that they offered such courses. Most of the institutions permitted the application of graduate technical course credits toward the requirements for graduate degrees. However, the majority of the institutions did not require technical credits for the master's degree or for higher degrees.

An innovative approach to inservice education for drafting teachers was reported by Sredl (1966c). In-plant workshops were operated with a rotational scheme which permitted teachers to spend specified lengths of time in training sessions within each of three organizations utilizing contemporary drafting processes. This method would appear to offer considerable potential for graduate study; additional developmental and evaluative studies of in-plant upgrading would appear to be promising.

An increasing percentage of graduate study in industrial arts education is being accomplished in the various institute programs. Several reports are of interest for the purposes of this review. Manchak (1966) described the operation of the first generation of NDEA Title XI Institutes for graduate study in industrial arts. Hackett and others (1966) visited and evaluated the 1966 institutes and suggested procedures for the operation of subsequent programs.

Bohn (1967) reported on the activities in an NDEA Institute for improving technical competency, and Baysinger (1967) evaluated a series of institutes for preparing fluid power teachers. The 1967 NDEA Institutes were evaluated in terms of their impact on the professional preparation of the industrial arts teachers by Crouch (1968). His evaluation indicated that both the instructional programs and professional activities of the participants changed as a result of participation in the institutes.

On the surface, it would appear that the majority of graduate degree programs have been relatively unaffected by the innovative approaches which characterized the institute programs for industrial arts teachers. Little research effort has been devoted to the evaluation of graduate programs, or the development of techniques for stimulating the dissemination of information about innovative approaches to graduate study in industrial arts.

## ADMINISTRATION AND SUPERVISION

Studies in the area of administration and supervision of industrial arts were wide ranging and reflected interests and problems at all levels. Several studies centered on the evaluation of attitudes; others dealt with the many factors involved in successful supervision and financing of programs; a few attempted to identify individual characteristics which could be used for the prediction of success in teaching.

Recent federal legislation greatly increased the sources of financial support for industrial arts. The American Industrial Arts Association sponsored a conference designed to provide administrators with guidelines for determining sources of financial aid for industrial arts programs. The report of this conference (American Industrial Arts Association, 1966a) is a compilation of the available sources of funds for industrial arts.

Accurate cost prediction is an important factor in the effective administration of industrial arts. District-wide cost figures for regular academic classes and industrial arts classes were used to determine the cost of industrial arts instruction (Heath, 1967). Careful analysis revealed that the average cost of industrial arts was higher than the cost of the regular school program; the excess cost averaged 27.1 percent per student contact hour per year. Translated into dollar equivalents the mean cost of industrial arts in a large urban district was $109.38 per student contact hour per year. There was considerable variation in cost among the industrial arts subjects studied with automotive instruction being the most expensive and drafting the least expensive.

Carrel (1966) compared the opinions of specialists, classroom teachers, and administrators regarding the functions of a state supervisor of industrial arts. The results indicated a high level of agreement between these groups regarding the role, function, and services that should be provided by a successful state supervisor.

The relationship of personality to teaching success was studied by Meosky

(1967). Practicing industrial arts teachers who had graduated from a teacher education institution over a three-year period were given a personality factor questionnaire. Each teacher's principal and industrial arts supervisor completed another supervisory rating instrument; these ratings were used to identify the most successful and the least successful teachers. None of the 16 factors in the personality instrument successfully differentiated between the groups of most successful and least successful teachers. Supervisory ratings were skewed toward the top of the scale and were related to college grade point average and teaching experience. The principal's rating tended to be closely related to the supervisor's rating for the teachers in this study. Margulies (1968) conducted a similar study in which supervisors' overall ratings were compared with their ratings on three specific dimensions of teaching competence. Competency in teaching techniques tended to differentiate, to the greatest degree, between the most effective and least effective teachers.

The public relations value of "open houses" was evaluated by Hoverson (1967). An attitude instrument was administered to parents at the beginning of the school year and again following an open house program seven weeks later. Results of the study indicate that parents' attitudes were influenced to a greater extent by having their children enrolled in industrial arts courses than by a project display and a brief teacher presentation describing the program.

Administrators and school board personnel in small schools were surveyed by Humbert (1967) to determine their attitudes toward industrial arts. Both administrators and school board members representing schools with industrial arts tended to be more favorable toward industrial arts than were individuals from schools with no programs.

The limited number of studies related to the administration and supervision of industrial arts is, on the other hand, explainable in terms of the similarity of supervision of all types of educational programs. Therefore, studies related strictly to the supervision of industrial arts may be either inappropriate or unnecessary in some areas. An equally plausible reason for the small number of studies and the lack of a consistent pattern to the studies is that an extremely small number of people who are either engaged in, or interested in, supervision find time to conduct carefully conceived studies in the area.

Despite these limitations, it is encouraging to note that researchers are exploring critical problem areas: attitudes toward industrial arts, determinants of teaching success, instructional costs, and the need for supervisory activities. From the bases provided by these studies, future researchers should find it possible to move toward more definitive studies of direct value to the industrial arts supervisor and administrator.

## EVALUATION

Evaluation efforts in industrial arts have centered on two distinct areas during the time span covered by this review. One group of studies aimed at the development and standardization of achievement tests. A second general category included studies designed to evaluate characteristics of industrial arts programs.

## Test Development

Several attempts have been made to develop standardized achievement tests in a given subject matter area within industrial arts. While test development and standardization is not necessarily directed at the evaluation of a program of instruction, it is a necessary first step in any such evaluation. Improved achievement test construction is also imperative if the profession is to attain a level of objectivity which permits the identification of a specific level of student performance.

An achievement test for high school woodworking was developed by Box (1967). The content of the test was identified by a study of the state curriculum guide and the state-adopted textbooks for woodworking in the State of Texas. After pilot testing, the 70-item test was administered to over 2000 students to obtain data for norming. Reliabilities, percentile ranks, and item difficulties were computed for each of the grades nine through 12.

In a similar endeavor, Morgan (1966) constructed an achievement test for basic electronics concepts and applications. Content validity was established by drawing content from the Minnesota curriculum bulletin and by obtaining the evaluative opinions of electronics instructors. Over 1000 eighth-grade students participated in the norming study for the 48-item instrument. The reliability and difficulty levels were considered to be satisfactory for utilization of the instrument to obtain uniform assessments of student achievement on a statewide basis.

Baker (1967) reviewed the arguments for standardized testing in industrial arts, as well as the pros and cons of the establishment of uniform testing procedures. Wright (1966) provided suggestions and sample items for the preparation of a drafting achievement test which would assess manipulative performance in addition to cognitive processes. Both Baker and Wright indicated that the overall values of standardized testing–as a tool for research, a valid base for grade assignment, and an aid in the diagnosis of individual learning difficulties–outweighted its disadvantages. However, they recommended care to avoid the common objections to testing in the operation of a program of standardized achievement testing in industrial arts.

Interest in standardized achievement testing continues to occupy relatively few industrial arts educators. Appropriate test development activities are an important part of curriculum development and evaluation activites. In addition, comparative studies of achievement are dependent upon effective instrumentation; this is seldom possible when researchers must rely upon tests developed for the purposes of their specific research. It is vital that an adequate array of appropriately normed instruments be prepared and made available to researchers and teachers in industrial arts if they are to evaluate learning of contemporary content, as well as traditional industrial arts subject matter.

## Evaluation of Programs

Program evaluation has been the subject of renewed interest in industrial arts. No doubt some of the motivation has been a direct result of past criticisms of industrial arts practices and procedures. Critical comments have come both from within the profession and from concerned individuals outside of it. Both groups have observed a disparity between state objectives and the content of industrial arts programs.

The American Council on Industrial Arts Teacher Eduction has, through its yearbook series, stressed the importance of program evaluation. Yearbook Sixteen (Nelson and Sargent, 1967) was devoted to the evaluation of contemporary industrial arts programs. Yearbook Fifteen included two important chapters on evaluation: the chapter authored by Sommers and Face (1966) discussed research related to the achievement of industrial arts objectives, while the chapter by Koble and Thrower (1966) presented an overview of research in the evaluation of industrial arts programs.

Several studies have evaluated the extent to which instruction in industrial arts has contributed to the acquisition of selected skills and knowledge. R. G. Anderson (1967) developed an occupational information test and administered it to a sample of high school senior boys. Students who had taken either graphic arts or metals had more knowledge about the occupational opportunities than did those who had not taken the courses. Students who had taken both courses were more knowledgable than students who had only one course.

The achievement of three selected objectives of industrial arts was assessed by Dennis (1967), using a pretest, posttest design with a sample of high school junior and senior boys. The results of his study indicated that enrollment in industrial arts during the semester of the study improved the students' interest in industry and the problems of production and exchange. However, industrial arts students did not gain significantly more than students enrolled in other high school subjects in terms of their progress toward the development of desirable health and safety attitudes and practices or the development of habits of orderly performance.

It is indeed refreshing to note the interest in the evaluation of the attainment of the objectives of industrial arts. While research efforts have not yet provided conclusive evidence that industrial arts objectives have in fact been achieved, the assessments in the studies above provide a necessary step toward the accumulation of such evidence. Additional research efforts are needed, preferably using contemporary statements of industrial arts objectives as guidelines. Student performance data on appropriate criterion measures should be used to test the attainment of objectives relative to manipulative performaance.

## RESEARCH

This section includes references to publications which have dealt with the process and/or product of research in industrial arts. Reviews and summaries of research in industrial arts have appeared with increasing frequency in recent years. They are included here with such comments as may help to identify their coverage so the reader may consult the ones of particular interest to him. Publications on the establishment of research priorities and the development of theoretical models to guide research efforts have also been included; these provided a new sense of direction for research in industrial arts.

The first edition of the present publication (Streichler, 1966) marked the first systematic summary devoted exclusively to research in industrial arts. Industrial arts research, as part of the research in vocational, technical, and practical arts education, was included in a recent issue of the *Review of Educational Research* (Moss, 1968).

Several other tabulations of research have appeared. Johnson (1967a, 1967b, 1968a, 1968b) published a series of listings of recently completed doctoral research. The *Journal of Industrial Arts Education* included a summary of doctoral research in process ("University Research Review", 1967). Baker, Fowler, and Schuler (1967) reviewed research on the teaching of electricity/electronics.

The difficulty in identifying and locating research relevant to specific problem areas in industrial arts has been documented by Weir (1968); the problem has been persistent. Taylor and Wilson (1968), however, reported on assistance available through the Educational Resources Information Center (ERIC) retrieval system. Parenthetically, it should be noted that most doctoral dissertations, which comprise a major portion of the research in industrial arts, are not included in the ERIC system. Dissertations from most universities may be identified by consulting the appropriate issues of *Dissertation Abstracts.*

The *Journal of Industrial Teacher Education* (Fall, 1968) included a series of articles which discussed the status and needs of research in practical arts and vocational education. Hanson (1968) presented an overview of research needs in industrial education. She pointed out the need for the development of industrial education researchers who are competent in research methodology and supported by adequate funding. These criteria were held to be necessary to the effective scientific approach to the study of the problems in industrial arts education.

Wimer (1968) and Impellitteri (1968) discussed the roles of the practitioner and the research specialist in conducting research. Wimer emphasized the importance of a close working relationship between the practitioner and the researcher as they worked together to solve practical problems. Impellitteri pointed out that this approach would be most fruitful only in those areas where the competencies of the practitioner and the researcher overlapped; in other areas, such close coordination might not be practical. Impellitteri proposed the preparation of a new type of specialist, a practitioner-researcher, whose sphere would encompass all types of research problems except those at the extremes of the applied-basic research continuum. He also emphasized that the practitioner must be an intelligent consumer of research.

Tuckman (1968) indicated the need for basic research, the development of innovations, and the controlled evaluation of demonstration activities. Increased funding, better research training, and appropriate changes in the attitudes of professionals in the field were considered to be prerequisite to the operation of an adequate program of research in industrial arts and vocational education. Arnold (1968) criticized the fragmented nature of research efforts, the failure of researchers to explore important problem areas, the unnecessarily complicated reporting of research results, and the lack of emphasis upon research dissemination.

The American Vocational Association Research Committee (1968) defined a proposed research policy for the AVA. The statement recognized the responsibility of the professional association to stimulate and facilitate research and research-related activities. The long-range goal of research was identified as the improvement of educational practice. It was recognized that the attainment of that objective would require a continuous flow of information between researchers and practitioners and substantial, long-term financial support. The appearance of a statement of long-term priorities and policies to guide research and development is a positive step toward the evolution of a more coherent approach to research in industrial arts and related disciplines.

The trend toward improvement in the quality of research has been aided by the evolution of improved theoretical research models. The development of a framework for research on motor learning in industrial arts (Nelson, 1967b), is indicative of the type of conceptual approach required to guide research activities toward profitable outcomes. Nelson's model provided for four major variables: learning environment, input, learner, and performance. The structure of the model was designed to permit the evaluation of main effects as well as interactive effects among variables. Such a structure offers a way to integrate the findings of industrial arts research into a meaningful pattern, and should facilitate the development of more sophisticated conceptual systems as research procedures are improved and the findings of controlled investigations are synthesized.

## SUMMARY

Industrial arts appears to have come of age academically and intellectually. The profession has matured to the point where it is willing to undergo a careful self-appraisal of its basic beliefs, fundamental practices, and educational procedures. As a result, critical yet objective investigations have been conducted on a wide variety of important topics in industrial arts.

A sample of the excellent studies cited in the review provides ample evidence of the professional maturity and research competence which is becoming evident in industrial arts research. A commendable level of sophistication was apparent in Nelson's (1967b) efforts to define a model for research in motor learning in industrial arts. Kicklighter's (1967) nine-level taxonomy was but one of several attempts to develop logically consistent, internally stable models for content selection and curriculum development. In teacher education, Sedgwick's (1966) effort to derive a model for teacher education activities and to specify behavior changes demonstrated a degree of refinement that has not always been evident in earlier efforts. Teacher recruitment problems and the factors involved in career decision were systematically investigated by Foley (1967).

An increasing number of investigations in industrial arts have involved controlled experimental conditions. However, the selection and utilization of appropriate research designs remains a crucial problem. Researchers in industrial arts have not taken full advantage of the design assistance available in such works as the now-classic Campbell and Stanley (1963) chapter in the *Handbook of Research on Teaching*. Sampling techniques have not always been effectively used to maximize the generalizability of the findings of experimental research. The failure to include untreated control groups has limited the applicability of many studies to the comparison of differentially treated groups (and the reader must often deduce for himself the fact that comparison groups are sometimes mislabeled "control" groups).

The use of inferential statistics for purposes which are not exactly clear or methodologically sound should be discouraged. Researchers should not be reluctant to consult a reputable statistician, not only in the selection of the appropriate statistical tests, but also in the accurate reporting of the results of the application of statistical procedures.

Readers rarely read the entire report of any research, even when they recognize the importance of such careful study. It is, therefore, imperative that abstracts and summaries be carefully and accurately prepared to provide the appropriate information. The researcher should assume personal responsibility for seeing that his investigation is accurately described in ways which will communicate to the probable reading audience.

Graduate programs in industrial arts education should assume full responsibility for the preparation of researchers and practitioner-researchers competent to conduct reputable research. Specific recommendations for such graduate programs are not appropriate here; it is sufficient to note the need for them and to encourage an appropriate research base for graduate study, particularly at the doctoral level.

The general impressions resulting from the preparation of this report are highly favorable ones, indeed. While the preponderance of studies in industrial arts are still done to satisfy the requirements for advanced graduate degrees, many doctoral studies are being published as journal articles, frequently rewritten for the reading audiences of the respective periodicals. As a consequence, the results of research are now available and intelligible to a much larger audience than will be directly affected by the dissertations alone.

An increasing number of studies in industrial arts are being conducted upon a sound base of theory. This is a necessary first step toward the accumulation of a body of knowledge in industrial arts.

One of the most encouraging of the tendencies noted during the three-year period of this review is the marked trend toward action research in the industrial arts classroom. Teachers have demonstrated a definite tendency to look for a better way and to evaluate the results of their efforts. Such an approach throughout the profession predicts a healthy future for research in industrial arts.

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